P-19: Sono-recovery of copper from deep eutectic solvent based on choline chloride

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During the last decade, the continuous growth of the electronic equipment market leads to an increasing amount of scraping. At the beginning, the recycling of Waste Electric and Electronic Equipment (WEEE) also called e-waste was mostly managed for environmental reason due to its hazardous material contents (copper, lead, tin…). Today the major economic driver for recycling of electronic waste is the recovery of valuable materials, particularly precious metals (Cui (2008)) and copper. In addition to ecological and economical benefits, the recycling of this so called "urban mine" finally offers a significant secondary resource potential which will probably becomes essential in the next years. Nowadays, it is thought that one third of the copper stock is already present within the urban mine (in-use stock) (Gerst (2008)).

The recycling chain of e-waste includes several subsequent steps which are (Hagelüken (2006), Hagelüken (2005)): collection, dismantling, preprocessing and finally smelting and refining. Following the preprocessing step (mechanical treatment), noble metal and copper extraction can be achieved by hydrometallurgical processes. The initial step in such process consists in the leaching operation which corresponds to the solubilization of solid metals by a solvent into metallic cations or complexes. The solution is then subjected to separation, solvent extraction, and purification in order to upgrade the metal of interest content. Finally, recovery of the metal is obtained by electrodeposition of the metal either by electrochemical or chemical reduction of the metallic compounds (cations or complex) in the solution.

The aim of the present study is to develop a new sustainable process for copper recovery from e-waste leaching solutions. The process described herein concerns the sono-electrodeposition of copper (at 20 kHz) from both aqueous and Deep Eutectic Solvents (DES). DES electrolytes are a subclass of ionic liquids, made of ionic mixtures forming a eutectic with a melting point well below than of the individual components. They appear to be good leaching agents (Pollet (2008)) and are also considered as green solvent. Moreover, they are a lot less expensive than organic ionic liquids so that their use at pilot-scale is easily considered. The DES used in the present work is made of a mixture of choline chloride and ethylene glycol (1:2 molar ratio) present a viscosity of 21 mPa.s at 25 °C. The use of ultrasonic stirring allows to counteract the negative effect of viscosity on the mass transport. Indeed, the mass transfer coefficient recorded with ultrasound is many times greater than with a classical RDE rotating at 2000 rpm. Preliminary electrochemical investigations on Cu^{2+} reduction in both media were performed to determine the best deposition conditions (current density, ultrasonic power,…). Copper recovery was finally achieved with a recovery rate of 90% (C/C0 = 10 %). The use of ultrasound permitted to reduce the electrolysis time of 30 % for the same gain.

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